

Small Dishes for 1296 EME Dxpeditions by Allen Katz, K2UYH

Abstract: There is much interest in small scale EME dxpeditions. For 1296 operation, an antenna with suitable gain that can be transported as luggage on an airline is needed. This paper describes a light weight 7' diameter stress dish and mount that can be carried in a 3.5' x 0.5' x 0.5' package, and its use on a 23 cm dxpedition to Bermuda.

Introduction: I recently had the opportunity to travel to Bermuda. There had never been a QSO on 432 or 1296 MHz EME from Bermuda. Thus operation on either or both of these bands was of great interest to the EME community. Two years ago I tried to operate from Bermuda on 70 cm EME with a single yagi [1]. I considered operation on both 70 and 23 cm, but decided to operate on 70 cm because of the availability of equipment for 432 at VP9MU's QTH. The attempt was unsuccessful mainly because both of the preamps I brought with me were damaged in transit. [Do not put any sensitive equipment in your luggage]! This time I hand-carried all the electronics.



Figure 1. The complete EME station fit in one box and a carry-on bag.

On the available weekend, the moon was too close to the sun to allow 70 cm operation with a single yagi. Also VP9MU could not be located. This left only the

possibility of operation on 23 cm EME. Because of the poor moon conditions I considered abandoning any EME operation and just enjoying Bermuda's other attractions. But my better judgment prevailed and at the last moment I decided to give EME another try even though I knew it would be a long shot. I was breaking two of my key EME dxpedition rules: 1) Always have local assistance - I would be alone on the island with no chance of help, if I forgot or had something breakdown; and 2) always plan and announce an EME dxpedition well in advance.

Choice of Antenna: Although the use of JT65 has allowed EME QSOs to be made with a single yagi on 23 cm, I wanted to have an antenna that would allow QSOs with stations on CW [2,3]. CW remains the preferred, if not the exclusive mode of many 23 cm EME operators. (The close sun and moon spacing also dictated the use of an antenna with sufficient gain to reject the sun's noise). Based on past history, an antenna with the aperture of a 2 m dish or greater seemed required.

Previously I had built a 7.5' offset stress dish that I intended but never used for my earlier dxpedition attempt [4]. This offset dish (OD) worked well and could have been used for this dxpedition, but I decided to try a conventional dish (CD). My reasons were two fold. Firstly, I could make the petals of a CD dish smaller. Both dishes were based on an approximate 7' diameter. The petals of the OD dish were about 7' long, while those of the CD were only half this size. This allowed the full dish to be package in a container of half the length and cause less attention at the airport. Secondly, I felt that

I could more easily find the moon with a CD. I had found that with the feed mounting arrangement of the OD, it was not always obvious where to point the dish. With no chance of a visible moon during the dxpedition, it seemed that using the CD would eliminate a potential cause of error.



Figure 2. 7.5' offset dish intended for use on first Bermuda dxpedition in 2004.

For small size dishes, feed blockage can reduce antenna efficiency. The OD concept eliminates the feed blockage problem and is an advantage of this design [5]. Sometime in the future I plan to make side by side comparisons of the two designs.

Virtually all 23 cm EME stations use circular polarization. The use of circular polarization provides an effective gain increase of 3 dB over a linearly polarized antenna. Both CDs and ODs can be easily fed circularly polarized and provide lots of gain, but they also provide considerable

additional weight and size. Stress dish designs can solve the problem of weight. Considering the pros and cons, I decided to use the CD approach.

Stress Dish: The concept of a parabolic stress dish goes back to my high school days when I conceived and built a 30' dish that I believe is the first stress dish design. Later I used a 20' stress dish for many 432 EME dxpeditions [6]. This dish is still in use and was last used by W2WD for his 70 cm dxpedition to Nebraska in 2002.



Figure 3. 20' stress dish on first Delaware dxpedition in the 80's.

For this dxpedition a dish of 7' diameter was decided upon as compromise between portability and gain. The surface was produced from eight 40.5" lengths of $\frac{1}{2}$ " x $\frac{3}{4}$ " wood molding stock - readily available at the local Home Depot. Each *spoke* has two holes drilled at 0.5" and 2" in from the outer end. These dish *spokes* are attached to an octagonal shaped center hub made from a 1' square piece of 1" plywood by cutting off 3.5" at the 4 corners. Each *spoke* overlaps the hub by 3" and is clamped in place using two small pieces of wood made from the same stock as the *spokes* - see Figure 4. (It would have been preferable to make channels into which the wood spokes could be inserted for attachment. I used this method of attachment for the 20' stress dish shown in Figure 3. This arrangement is

stronger and makes assembly and disassembly quicker, but with only eight spokes the added effort was not considered necessary).

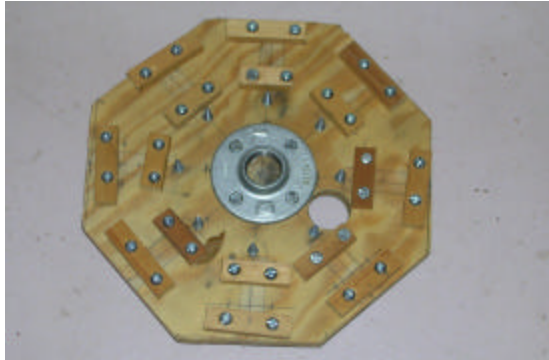


Figure 4. The *spokes* are attached to the plywood center hub with 2 wood clamps.

Two 1" pipe flanges are bolted to the center of the top and bottom of the hub for respectively attaching the feed support and mounting the dish. A 1" hole was also cut into the hub to allow access for the feed line and control cables.

A rim around the outside of the reflector is formed from eight 32.5" lengths of the 1/2" x 3/4" wood modeling stock with mounting holes 0.5" in from each edge. Each *rim segment* is attached to one of the *spokes* using a 10-32 eyebolt (placed in the outer end hole) to form a *petal* of the dish.



Figure 5. A *petal* is formed from a *spoke*, *rim segment* and aluminum screening.

A 10-32 bolt is used to fasten the *rim segment* to the adjacent *spoke* by the lower hole (at the time of the dish assembly). A trapezoidal shaped piece of aluminum screening is also attached to the *spoke* – see Figure 5. (For shipping, the *rim segment* is moved over the *spoke* and the aluminum screening rolled around the two pieces with the eye bolt left in place as shown in Figure 6).



Figure 6. For travel the aluminum screening is rolled around the *spokes* and *rim segments*.

The length of the *rim segment* is critical and must be correctly calculated (cord of a circle) and cut to achieve the desired dish shape. (Wood dimensions are given to the closest 1/4" and should not need greater precision). Its length was chosen to produce a reflector with an f/d ratio of about 0.55. (This f/d matches reasonably well the dual dipole feed chosen for use with the dish). The relationship between the diameter and depth of a parabolic reflector is given by the equation:

$$X^2 = 4PY$$

where X is radius of the reflector, Y is the depth and P is the focal distance. The shape of the curve used for this dish is shown in Figure 7. The deeper the dish, the shorter the focal distance and the wider the beam width of the optimum feed antenna. The length of the overlapping *spoke* and hub is longer than the diameter of the dish and integrates out to be 43.5" from which the 40.5" *spoke* length is determined. The two

holes in the *rim segment* are placed 0.5" in from the ends and are 31.5" apart.

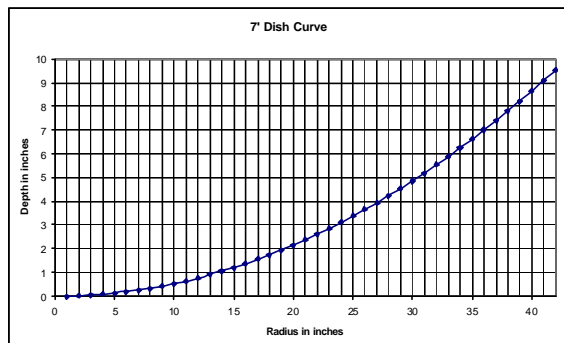


Figure 7. Shape of the dish's curve.

The dish's focal length is about 46.25" long. To keep the dish light in weight, a 1.25" diameter aluminum pole is used as the main support for the feed antenna. One end of this pole is cross slit and attached to a 1" pipe nipple with a hose clamp. The pole can then be screwed into the pipe flange as shown in Figure 8. Eight holes are drilled into the opposite end and used to secure 8 ropes that are used to pull up the *spokes*.



Figure 8. Installation of feed support

These ropes guy the *spokes* and facilitate the dish assembly, but are not tightened to the point where they distorted the dish shape. The dish shape should be set by the length of the *rim segments*.

Feed Antenna: The feed pole is extended with a hook made from four lengths of 1" square aluminum stock that was used to hold the feed antenna at the center of the dish. A feed formed from orthogonal dual dipoles with a quadrature hybrid is used to produce circular polarization. The dual dipoles were chosen because of their relatively small size. An IMU horn would be an excellent choice for a feed antenna, but would add significantly to the size and weight and be difficult to transport.

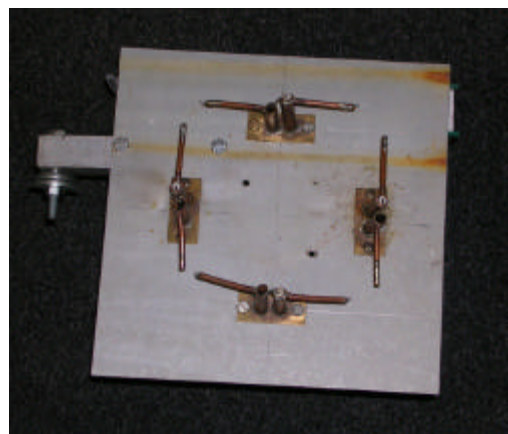


Figure 9. Dual dipole feed antenna.

Mount: An AZ-EL mount is assembled from 1" plumbing fittings. Only a tee and an elbow connected with two nipples are required. The components of the mount are shown in Figure 10.



Figure 10. The mount is made from 1" plumbing fittings.

One nipple connects the flange at the back of the dish to one end the tee. The second nipple connects the center of the tee to the

elbow and serves as the elevation axis bearing. Two additional nipples are used to allow aluminum poles to screw into the mount (in an identical fashion to the feed support pole). One is for the vertical support mast, which connects to the other side of the elbow and provides the azimuth axis bearing. The other connects a pole for counter weight to the opposite end of the tee, as can be seen in Figure 13. This pole was secured with a rope to hold the elevation angle. Figure 13 also shows the inclinometer used for elevation readout and the protractor (white cylinder) used for azimuth readout.

Covering: The dish is covered with aluminum screening. This material is available in the US in 3' width by 25' long rolls. Two rolls were needed to cover the dish. The screening is cut into eight trapezoidal pieces - one for each *petal*. One side of the screening is attached to a *spoke* with wire (~ #24) stitching. The screening pieces are made wide enough to overlap the next spoke, but are not connected. Neither is the screening attached to the *rim segments*. When a *rim segment*, during the assembly of the dish, is bolted to the adjacent *spoke*, it is also used to bolt the aluminum screen in place. A hole is placed in the screening to facilitate this process. After all the *petals* are in place, a few short lengths of wire are run through the mesh and used to temporarily tie the screening pieces to their corresponding *rim segment* and the adjacent *spoke*.

Assembly: The dish can be assembled (or disassembled) in less than an hour by a single person. The main vertical mast is first tied to a rigid structure. I had intended to use the railing on the balcony of my hotel room for this purpose, but had to change my plans. I ended up using a picnic table to hold the mast.



Figure 11. Start of dish assembly

The mount is screwed into the mast and then the center hub of the dish is screwed to the mount. The mount is set so that the hub is pointing vertically, and the center feed support pole screwed to the hub. A *spoke* is next slid under the clamps on the hub and bolted in place.



Figure 12. The *spokes* (*petals*) are attached to the center hub one at a time

This process is repeated until all the remaining 7 *spokes* (and *petals*) are attached. (I added screw stops, so that the *spokes* would always be at the correct depth). The ropes from the center support are attached to the corresponding eyebolt on the end of the *spokes*. Small turn buckles with hooks are used to attach the ropes. The *rim segments* of each *petal* are then moved so they are at a right angle to the *spokes* and

bolted to the adjacent *spoke* along with the aluminum mesh. Extra wire is used complete the attachment of and smooth out the mesh as already discussed. Finally the feed assembly is bolted to the center support pole and the preamps, relays and feedline connected.



Figure13. Completed dish and mount in operation.

Testing/operation: The dish was basically constructed in a single weekend with no time for testing before the trip. Sun noise was measured for the first time in Bermuda. I used the reflection of the sun on the dish to calibrate my tracking system. It was gratifying to hear a significant increase in noise level when the sun's shadow was at the center of the reflector, but did not have a way of quantifying the actual level.

The rest of the system consisted of a TS2000X, Down East Microwave (DEM) 150 W SSPA, a low noise preamp and a 13 V switching power supply. (N2CEI of DEM was kind enough to lend me the PA, which was one of their demo units. Steve's generosity made the dxpedition possible).

I arrived on Thursday afternoon and discovered my hotel room was not where I expected. Unfortunately my room was

facing to the west and not south as I had requested. I was told they were totally booked and a south facing room was not available. I was able locate a place a short distance from the hotel where I could get power and setup the dish. The only problem was that I had to connect and reconnect my equipment each day. I left the dish, feed and preamps in place and never had a problem with someone disturbing them.

I completed the assembly of the dish the first day. Because of my schedule, I was only available in the afternoon, which limited my setup time. On Friday I added the feed, but loss my balance and damaged the dish. I was able to make repairs, but lost time and did not have everything connected until after the end of the European moon window, and when the moon was too close to the sun. I did verify that I was receiving sun noise. On Saturday the sun and moon were synced and operation was impossible. The only thing I did was change the connections to hybrid. I thought I had set the circular polarization to the wrong sense and changed the connections based on new information I had received via e-mail. As it turned out this was a mistake. Only one day remained for operation, Sunday, as I was leaving on Monday. On Sunday I was able to start a little before noon, but heard no signals. I ran several skeds with nil results. I thought I might have a tracking problem and played with the position of the dish. Then a strong pulse noise, possibly from a radar, showed up and put me out of business. After about two hours this noise disappeared, and I able to resume EME operation, but still detected no signals. When I could not find HB9Q on JT65C, I finally decided to try switching polarization. It took longer then I expected to make the change, and I missed the end of Dan's sked. I telephoned N2UO to tell him not to bother

going to my QTH to try and work me as the system was not working. I also asked Marc to e-mail everyone on my skeds list saying that I would try calling CQ with the reversed polarization setting on JT65C. I did not expect success. To my surprise I almost immediately copied G4CCH calling me (-21 dB) and worked Howard as quickly as possible. I then copied OE9ERC calling, but Erich never sent reports – the moon was at 2 degrees at his QTH. I phoned Marc to ask him to go to my QTH and give me a try. Unfortunately by the time he arrived, the moon was going behind a wall. I copied Marc sending to me, but he never detected my signals. I guess I will have to try again.

Conclusions: A small stress dish appears a good choice for future 23 cm dxpeditons where the antenna is to be transported as luggage on a commercial airliner. The dish described in this paper should be considered for this purpose. It or the OD described in my earlier paper are starting points that can be modified and tailored using available materials to specific station needs. Both designs offer a relatively inexpensive and simple way of obtaining an antenna for portable EME operation on 1296. They both provide enough gain to make both CW and JT EME QSOs, yet can be disassembled into a small lightweight package.

References:

- 1] A. Katz, "K2UYH Report," 432 and Above EME Newsletter, June, 2004, <http://www.nitehawk.com/rasmit/NLD/eme0406.pdf>.
- 2] A. Katz, "Small Station EME on 70 and 23 cm Using JT44/65," http://www.nitehawk.com/rasmit/jt44_50.html.
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4] A. Katz, Small Offset Stressed Dish for Portable 1296 EME", Proceedings of the 11th International EME Conference, Ewing, New Jersey, Aug. 6-8, 2004.

5] P. Wade, "W1GHZ Online Microwave Antenna Handbook, Chapter 5, <http://www.w1ghz.cx/antbook/app-5a.pdf>.

6] A. Katz, "20' Portable Stress Dish," 432 and Above EME Newsletter, Oct. 1980, <http://www.qsl.net/pa3csg/Boek/BoekH3/art3-8.htm>.

Appendix: Dish/Mount Parts List

1 - Hub of 1'x1"x1" plywood with corners cutoff at 3.5" in and holes drilled as shown in Figure 4.

16 - 2"x0.5"x0.75" wood molding stock clamps with holes drilled 0.75" in from the ends.

8 - *Spokes* of 40.5"x0.5"x0.75" wood molding stock with holes drilled at 0.5" and 2" in from one end.

8 - *Rim segments* of 32.5"x0.5"x0.75" wood molding stock with holes drilled at 0.5" from both ends.

8 - Trapezoidal shaped pieces of aluminum screening cut as shown in Figure 5.

40 - ¼" bolts 2.5" long, nuts and washers.

8 - 10-32 eye bolts, nuts and washers.

8 - 10-32 bolts 1.5" long, nuts and washers.

2 - Aluminum poles 1.25" dia x ~ 3'.

1 - Aluminum pole 1.25" dia x ~ 1.5'.

5 - 1" pipe nipples.

2 - 1" pipe flanges for mounting on hub.

1 - I" pipe tee.

1 - 1" pipe elbow

3 - Hose clamps.

50' - Nylon rope.